Original Research Article

Estimation of Vertical Jump Height and its Correlations with Selected Anthropometric Variables in Indian State and National Level Gymnasts

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ABSTRACT

Introduction: Gymnastics is a multi-dimensional sport that demands a high level of physical fitness and skill to flourish, which is often a function of anatomic structure as well as heredity. A number of physical abilities play a significant role in the success of gymnasts such as speed, strength, endurance, agility, flexibility, balance and power. The study was conducted on purposively selected 306 (134 males and 172 females) state and national level gymnasts aged 15-25 years from Amritsar, Patiala, Jalandhar, and Gurdaspur districts of Punjab, India.
Methods: As many as eight anthropometric variables, such as, height, body weight, body mass index, biceps, triceps, subscapular and suprailiac skinfold and percent body fat, and one performance test, viz. vertical jump height were considered for the present study.
Results: The results indicated that national level gymnasts had significantly ($p<0.045<0.001$) higher mean values in all the selected anthropometric variables than their state level counterparts, showing significant differences ($p<0.008-0.001$) in all the characteristics, except BMI and biceps skinfold. The results of inter-correlation matrix of the studied variables showed a significant ($p<0.046-0.001$) correlation of the vertical jump height with all the selected variables except BMI, biceps skinfold, subscapular skinfold and percent body fat.
Conclusion: Body physique and morphological characteristics are important factors that influence the quality of gymnastics performance.
Keywords: Anthropometric variables, Vertical jump test, State and National level gymnasts.

INTRODUCTION

Gymnasts, in their daily routine, perform different types of jumps, especially on the balance beam, floor exercise and vault. However, tasks like bouncing, tumbling and short run-ups followed by dynamic take offs require the stretch - shortening cycle of muscles. The capability of the gymnasts to transfer their potential forces from distal to proximal body components during rebounds events as involved in acrobatic skills such as somersaulting and twisting is very vital. [1] Jumping ability of gymnasts is often concomitant to successful performance and is sometimes considered as an overall indicator of gymnastics proficiency. The usual number of jumps with both legs is 1000 to 2000 per week, if all acrobatic elements are considered. [2]

Explosive muscular power, that is the ability to generate muscular work in a

short time, and the rate of force production are the basis for gymnastic actions. [3] Explosive strength, floor reaction time, flexibility and anthropometric features account for 41% of the success in performing the rhythmic gymnastics. [4] Motor performance skill tests such as vertical jumps are commonly used to evaluate the changes in the muscular strength and power.

Gymnasts both male and female, differ significantly from the reference population in their physical and biological make up. [5] Several anthropometric profiles or physical characteristics indicate the selection of the players for the competition at higher level. The anthropometric and morphological parameters are sensitive indicators of physical growth and nutritional status of the gymnasts for their maximal performance. [6] It has been emphasized that the prerequisites for the success of gymnasts depends largely on their physical characteristics, namely somatic dimensions, somatotype and body composition. [7] Anthropometric measurements have traditionally been used in the identification of young talented female gymnasts. [8]

The association between the scores on each apparatus and the final standing that is inherent gymnast's technical skill is often dependent on their anthropometric profiles. In uneven bars and balance beam scores were consistently good predictors of final standing, suggesting that they have a marked influence on overall performance, regardless of the competitors' standard. [9] It has been suggested that in order to be a successful female artistic gymnast, they should display, or try to develop, a specific somatotype; similar to those who are already successful. [10,11] It has been found that elite gymnasts mostly exhibit a predominance of ecto-mesomorph type of physique. [12,5,13,14] This has also been shown in Brazilian elite gymnasts. [15,16] It has also been suggested that success is linked to the significant positive relationship of mesomorphy to physical performance. [17] Body proportionality has also been shown to

be related to success; mostly using z-phantom strategy. [18-21]

Though the importance of explosive power is immense, literature related to it in gymnasts and its correlations with anthropometric variables is scanty, especially in Indian context. Thus, estimation of power is essential to gymnasts for their high quality performance. So the present study was planned with an objective to evaluate the vertical jump height of the state and national level gymnasts, and to search its association with selected anthropometric variables.

MATERIALS AND METHODS
Participants
The study was conducted on purposely selected 306 young state and national level gymnasts (172 females and 134 males) aged 15-25 years. The present study was cross-sectional study. The data was collected from various sports complexes, gymnastic Halls of Amritsar, Patiala, Jalandhar, Gurdaspur districts of Punjab, India. The study was approved by Institutional Ethical Committee. All the participants were informed about the study procedure and subsequently signed informed consent was taken from them. Age of the subjects was calculated from their date of birth registered in their respective institutes. The data was collected under natural environmental conditions in morning (between 8:00am to 12:00 noon) and in evenings (between 5:00pm to 7:00pm). Gymnasts with any recent injury, and any musculoskeletal, cardiac, respiratory, metabolic or systemic illness were excluded from the study.

Vertical Jump Height Measurement
For vertical jump height, the gymnasts were asked to stand side on to a wall and reached up with the hand close to the wall. Keeping the feet flat on the ground, the point of the fingertips was marked or recorded (standing reach). The gymnasts put chalk on their fingertips to mark the wall at the height of their jump. They then were asked to stand away from

the wall and jumped vertically as high as possible using both arms and legs to assist in projecting the body upwards. Attempt was made to touch the wall at the highest point of the jump. The difference in the distance between the standing reach height and the jump height was the score. The jump distance was measured in centimeters. The measures were taken three times and the highest value was recorded.

Anthropometric Measurements

All the eight anthropometric variables were assessed with the techniques provided by Lohmann et al. [22] All the anthropometric variables studied were measured in triplicate with the median value as the criterion. The height was recorded during inspiration using a stadiometer (Holtain Ltd, Crymych, Dyfed, UK) in cm. The weight was taken in minimal clothing, barefooted, using standard weighing machine in kilograms. Body mass index (BMI) was calculated using the standard formula weight (kg)/ height (m^2).

Skinfold thickness was measured using Harpender skinfold caliper to the nearest millimeter at four sites on all the subjects i.e. at biceps, triceps, subscapular and suprailiac areas. Percent body fat was assessed from mathematical equations derived using triceps and subscapular skinfold. The instruments were calibrated prior to use and all measurements were taken on the subject's right side with the subject standing in the relaxed condition.

Statistical Analysis

Student's t-test and ANOVA were tested for the comparisons of data. Pearson's correlation coefficients were applied to establish the relationships among the variables measured. Data was analyzed using SPSS Statistical Package for Social Science) version17.0. A 5% level of probability was used to indicate statistical significance.

RESULTS

Table 1 showed the descriptive statistics of explosive power test and selected anthropometric variables in state qnd national level gymnasts. Statistically significant (p<0.045-0.001) differences were noted between the state and national male and female gymnasts. The t- values of the selected variables were vertical jump height (t= 3.35), subscapular skinfold (t= 2.17), suprailiac skinfold (t= 2.01), and percent body fat (t= 2.29).

Table1: Descriptive statistics of vertical jump height and selected anthropometric variables in state and national level gymnasts

Variables	State level gymnasts (n=134)		National level gymnasts (n=172)		t-value	p-value
	Mean	S.D.	Mean	S.D.		
Vertical jump height (cm)	26.85	12.81	32.04	13.81	-3.350	<0.001
Height (cm)	159.95	11.92	161.01	8.88	-1.473	0.142
Body weight (kg)	54.38	7.57	55.31	7.31	-1.077	0.282
Body mass index (kg/m²)	22.19	10.62	21.37	2.60	0.994	0.321
Biceps skinfold (mm)	6.43	3.50	6.56	3.24	-0.342	0.733
Triceps skinfold (mm)	8.96	3.82	9.79	4.04	-1.813	0.071
Subscapular skinfold (mm)	9.48	4.11	10.52	4.18	-2.171	<0.031
Suprailiac skinfold (mm)	8.71	4.21	9.72	4.40	-2.014	<0.045
% body fat	12.43	4.17	13.53	4.10	-2.297	<0.022

Table 2: One-way analysis of variance of vertical jump height (VJH), selected anthropometric variables in state and national level gymnasts

Variables	SMG (n=62)		SFG (n=67)		NMG (n=72)		NFG (n=105)		F- value	p-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.		
VJH (cm)	29.76	13.01	24.15	12.10	35.39	13.24	29.75	13.79	8.769	<0.001
HT (cm)	163.57	14.81	156.59	6.88	167.43	7.85	156.60	6.57	28.909	<0.001
BW (kg)	57.87	6.97	51.15	6.65	59.63	7.23	52.34	5.74	29.260	<0.001
BMI (kg/m2)	23.23	15.14	21.23	2.28	21.28	2.26	21.43	2.81	1.169	0.322
BS (mm)	6.02	3.62	6.81	3.38	6.28	3.65	6.75	2.92	0.919	0.432
TS (mm)	7.99	3.80	9.87	3.65	8.66	3.86	10.57	4.00	7.189	<0.001
SS (mm)	8.72	4.07	10.18	4.05	9.73	3.90	11.06	4.30	4.468	<0.004
SIS(mm)	7.99	3.84	9.39	4.44	8.89	4.07	10.29	4.54	4.060	<0.008
% BF	9.96	3.80	14.71	3.07	10.84	3.57	15.37	3.36	47.628	<0.001

SMGP = state male gymnasts, SFG = state female gymnasts, NMG = national male gymnasts, NFG = national female gymnasts, VJH= vertical jump height, HT = height, BW = body weight, BMI = body mass index,BS= biceps skinfold, TS= triceps skinfold, SS= subscapular skinfold, SIS= suprailiac skinfold, %BF = percent body fat.

Table 2 highlighted the One way ANOVA of vertical jump height and eight anthropometric variables in state and national level gymnasts showing significant between-group differences (p<0.008-0.001) in all the variables except BMI and biceps skinfold studied among them.

Table 3 showed the correlations of vertical jump height with selected anthropometric variables in state and national level gymnasts. Vertical jump height had significant positive correlations (p<0.046-0.001) with all the variables, except BMI, biceps skinfold, subscapular skinfold and percent body fat.

Table 3: Correlations of vertical jump height with selected anthropometric variables in state and national level gymnasts

Variables	SLG (n=129)		NLG (n=177)		CG (n=306)	
	r	p	r	p	r	p
HT (cm)	0.030	0.740	0.116	<0.043	0.142	<0.013
BW (kg)	0.293	<0.001	0.223	<0.001	0.220	<0.001
BMI (kg/m2)	0.007	0.936	-0.002	0.967	-0.016	0.785
BS (mm)	0.078	0.378	0.019	0.740	0.009	0.881
TS (mm)	0.178	<0.043	0.050	0.382	0.043	0.455
SS (mm)	0.165	0.062	0.037	0.516	0.030	0.595
SIS(mm)	0.176	<0.046	0.080	0.162	0.078	0.172
% BF	0.078	0.379	-0.028	0.627	-0.035	0.545

SLG = state level gymnasts, NLG = national level gymnasts, CG = combined gymnasts.

DISCUSSION

Gymnastics is a highly challenging and demanding sport calling for a complex set of favorable traits for obtaining competitive success. Further, it has been shown that successful young gymnasts are part of a highly selected group in terms of motor skills and coordination, body size and shape. [23] The descriptive statistics of explosive power test and selected anthropometric variables in gymnasts showed statistically significant differences with higher means among national male and female gymnasts. As national level gymnasts are involved in high intense repetitive resistance training that often demands extreme flexibility. Their specific training is characterized by dynamic movements which elevate the core body temperature, enhance motor unit excitability, improve kinesthetic awareness, maximize active range of motion and improve technique by reinforcing critical motor programs as stated by Robbins. [24] The benefits of this kind of training were also reported in studies done by Kubo et al. [25]

Busko and Gajewski [26] reported gender differences, but when the results were calculated relative to body mass, the gender differences in some of the values were not statistically significant. In the present study, two variables i.e. body fat and BMI also showed statistically insignificant differences between male and female gymnasts. The measures of vertical jump height are higher in male's gymnasts than females. These results were also seen in a study conducted by Laffaye and Wagner [27] suggested that differences in jumping performance may have resulted from greater concentrations of androgens, higher relative amount of fast-switch fibers, maturation, greater muscle thickness and cross-sectional areas. [28-30]

Gymnasts body physique and morphological characteristics are considered an important factor determining the quality of the performance. [31,32] Generally it is observed that young gymnasts are thin, slender, with low mass, height, narrow hips and flattened shoulders. Present study showed non-significant association with BMI and percent body fat. Physical and physiological factors might be the reasons for these differences.

In the present study, significant correlations of vertical jump with height, weight, triceps and suprailiac skinfolds favors substantial evidence that somatotype and success in sport and physical performance are positively related. [33] The

results of the study done by Miletic et al. [34] supports the fact that a somatotype characteristic affects the performance, development and growth of gymnasts. The proportion of adipose voluminosity had a significant negative predictive value on performing higher amplitude explosive movements like jumps, rotation balance and flexibility.

CONCLUSION

Significant differences were found in all the values studied except, BMI and biceps skinfold. Also vertical jump height was positively correlated with all the traits except BMI, biceps skinfold, subscapular skinfold and percent body fat. This would lay emphasis on the fact that body physique and composition are the predictors that will set limits to gymnastics abilities.

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